Digital Bodies

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Bodies

Introduction

Since its early beginnings, the human figure and especially the human face have stood at the center of fictional cinema. Both have served as a projection screen for the spectator's emotions. However, the filmic apparatus has always fragmented, transformed, and enhanced the human body – in front of, in, or after the camera. In 1923, Dziga Vertov thus remarked in his essay *Kinoki – A Revolution*:

> I am the camera-eye. I create a person who is more perfect than Adam. I create thousands of persons according to various, previously devised plans and schemata [...]. From one I take the deftest hands, from another the slimmest legs, and from the third the most beautiful and most expressive head, and through montage I create a new, perfect individual.
>
> (Vertov 1923: 33)

Nevertheless, with computer-generated imagery (CGI) the techniques for fragmenting, transforming, and enhancing the human body have performed a historical leap.[1] It is the work on the body where the most significant changes can be observed, and from my research I have ample material for another book – about the foreign bodies of unknown peoples, extraterrestrial humanoids and strange creatures; about modified or entirely digital bodies performing incredible feats or bodies that are injured, even dissolving, or indeed invisible or subject to grotesque deaths; about bodies experiencing change as morphs; about cyborgs as man-machine hybrids; about bodies as textures formed by crowd animation; about bodies as material or as construction sites; about injuries and lacerations that show the skin's layers; and finally, about the technical extensions of the body.

Many scholars (see various essays in Frölich et al. 2001) consider the boom of body representation and transformation an immediate symptom of a highly engineered information society, which increasingly marginalizes the body. Its material or physical substance is perceived as an annoying obstacle, and indeed as an inert, flawed, pain-sensitive, and mortal

1 Recently, David N. Rodowick has made a similar observation in his book *The Virtual Life of Film* (2007: 6 et seq.)

mass that is no longer compatible with the intellectual and technological possibilities of the twenty-first century. A development toward a hypertrophic dissonance between body cult and disembodiment can be observed. On the one hand, the body cult turns the body into a project – subject to continuous transformation and optimization by primary interventions, among others fitness training, plastic surgery, piercing, and tattooing. As a consequence, such interventions shape the body into an expressive, performative figure, and superimpose socially conditioned semiotic and symbolic functions on nature. Various secondary symbolic systems, or what Roland Barthes referred to as myths (1957), such as clothes, jewelry, make-up and hairstyle, further this highly complex production of meaning through the expressive display of the body (Weingarten 2004: 31ff.).

Disembodiment, on the other hand, emerged with the onset of industrialization, and even more so with the rise of electric, electronic, and eventually digital technologies in many areas of life, among others communication, work, and entertainment. Modern urban society is shaped by a "hitherto unknown interlacing of anonymity and intimacy," as Gertrud Koch (2002: 230) observes with reference to Georg Simmel. This dual mode of social interaction becomes reformulated with mass media representation, and creates a "new horizon of expectation" that has the "advantages of intimate proximity and social distance at one and the same time" (Koch 2002: 232).

No one has offered a more trenchant analysis of the altered status of the body in contemporary society than Donna Haraway in her influential *A Cyborg Manifesto* (1985). Using the model of the cyborg,[2] she rehearses step-by-step how established categorial boundaries become increasingly blurred in the force field of contemporary science and technology, affecting the boundaries between animals and humans, between animated nature and machines, and eventually between the physical and non-physical. Haraway's second diagnosis is especially fruitful for my present discussion:

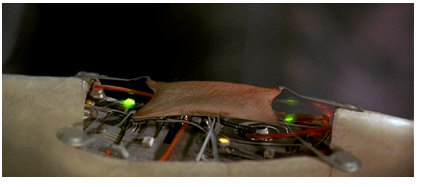
> Late twentieth-century machines have made thoroughly ambiguous the difference between natural and artificial, mind and body, self-developing and externally designed, and many other distinctions that used to apply to organisms and machines. Our machines are disturbingly lively, and we ourselves frighteningly inert.
>
> (Haraway 1985: 152)

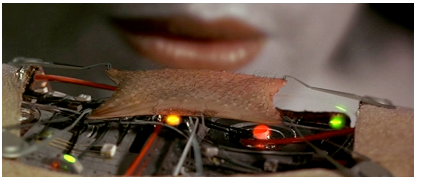
2 Vivian Sobchack stated that the cyborg "became somewhat tired and tire-some from academic overuse" (Sobchack 2004: 207). While this diagnosis certainly applies I would argue that there is no reason to abandon the concept altogether.

Haraway refers among others to modern reproductive medicine to exemplify her point. There, a close coupling of body and machine can be observed with the machine penetrating ever deeper into the body, and thereby rendering obsolete the natural corporeal shell. Haraway considers this change disturbing and at the same time promisingly utopian, since the transcending of boundaries might be both a threat and a revolutionary destruction of rigid patterns that mark the dawn of a new order: the ideology of the network. She thus follows – at least implicitly – Marshall McLuhan's notion of technological media as an extension of man. Space collapses into a network structure to become a global village.

In a striking manner, Haraway's metaphorical model captures the human-machine interaction characteristic of cinematic body representation. The dissecting operation of the camera – which Haraway describes as a hunting instrument (168) – is expressed in Vertov's observation cited above, while Walter Benjamin (1936: 31) compared the cameraman to a surgeon. The audience, as Benjamin further asserted (24), assumes the merciless stance of the camera, and thereby "tests" the actor's performance.

With regard to the upheaval in the digital domain, Haraway's comments have a prophetic quality: with the digital culture of quantification, fragmenting, and reassembling, the modification and construction of the body enter utterly new dimensions (see figures 1 and 2).





1, 2 Star Trek: First Contact: Human skin implanted into the cyborg's arm; sensory reaction

Whereas traditional techniques involved extensions of the body, including latex suits, prosthetics, and adhesive wounds, which supported the transformation of actors into strange or damaged creatures, digital procedures intrude deeply into the flesh, and thereby expose layer after layer, for instance in The Mummy (USA 1999, Stephen Sommers) or Hollow Man (USA 2000, Paul Verhoeven). Or they powder the body by means of particle animation to cause a wide array of grotesque manners of death. Each construction and even more so every single dissolution of a digital body presuppose painstaking analysis; each and every feature, however

inconspicuous, must be isolated and registered to be inserted into the data space of digital representation. The computer graphics artist – to echo Benjamin's metaphor – is an even more merciless surgeon. Ultimately, the digital reconstructions and modifications of the body correspond to those hybrid body images, which were marginalized as monsters for centuries (Haraway 1985: 180). They are impure figures, for instance centaurs and amazons, which Haraway (180) identifies as pollutions of the male warrior with animality and woman in Greek mythology.

Human-machine interaction in film has also changed in another respect. Cinema heroes have always been armed with a range of equipment, including weapons, vehicles, and most recently computers, sensors, and steering devices (Hoberg 1999: 120). Now, the hero's apparatus leads a far more complex double-life as a visible prop and as an invisible device. Retouched wires enable superhuman movements; morphing allows the seamless transition of the actor's body into its digital double. Unlike the majority of theorists, who – in close alignment with the dystopian visions of popular culture – perceive ever tighter human-machine coupling as a threat, Haraway (180) emphasizes its ironic and playful aspects: "Intense pleasure in skill, machine skill, ceases to be a sin, but an aspect of embodiment."

New digital possibilities not only dissolve the boundaries between outside and inside, but they also render more versatile the image of the human body. Such a versatile image approaches what Norbert Elias describes as an archaic self-perception of human beings that was "more fluid [...] at earlier stages in the development of mankind. In those times," he further asserts, "People may experience themselves, and may be experienced by others, as different persons with different names after an initiation rite, or after the assumption of a new social position" (1988: 68). In contrast to such discontinuous forms of self-perception and the perception of others, Haraway (180) considers the fluidity of contemporary identities rather as continuous regeneration that marks continuity in a society undergoing change, a society furthermore that has been compelled to cope with injuries. Haraway's metaphorical model of this conception of the body are salamanders, which recuperate after injury by regrowing the destroyed structures – often entailing distinct changes compared to their original anatomy.

Nowhere does the much-maligned spectacle of contemporary mainstream cinema become more evident than in the spectacular stagings of digital or digitally modified bodies. Such bodies transcend the physical boundaries of real, carnal bodies in all directions, and thus make their potential seem almost boundless. This is hardly accidental. Linda Williams

(1991), for instance, has poignantly described the well-established connection between excess and body-centered genres. Even more than all other forms of spectacle, such excessive body images meet with harsh criticism. Here, the puritan heritage of the German Enlightenment finds even more blunt expression in that the Cartesian dichotomy between body *(res extensa)* and mind *(res cogitans)* is interpreted to the disadvantage of the body.

During the Enlightenment, however, as Barbara Maria Stafford has remarked (1991: 253f.), French materialism represented an opposite pole to Johann Joachim Winckelmann's spiritualized sensualism and its ideal of the immaculate body, as represented by ancient Greek sculpture. According to Stafford (253), Julien Offray de La Mettrie's *Homme machine* (1748), much-cited in cyborg theory, and Denis Diderot's *Eléments de physiologie* (1778), both substantiated a fluid and instinctively erotic phenomenology, in which body and mind were one. Everything possessed a physical and chemical nature, "incessantly destroying, rebuilding, and transmuting rudimentary particles [...] to infinity. [...] As Diderot wittily quipped: 'the wise man is only a composite of mad molecules'" (Stafford 1991: 254).

Thus it is even more surprising that the body-mind dualism continues to exert such a fierce grip on the contemporary discourse on the relation between spectacle and narration. Furthermore, in the digital domain this dualism is a mere pseudo-difference, since the digital body is itself no longer a *res extensa* but instead an immaterial, ephemeral phenomenon, even if it is endowed with all the insignia of the somatic like any genuine wetware; namely, with blood, sweat, and all other body juices.

Since computer-generated body transformation and representation is such an extensive field, I have decided – albeit somewhat reluctantly – to focus on some few aspects, especially on the connection between different forms of digital body construction and audience participation. Discussing these forms would also fill hundreds of pages, and I hence lay no claim to exhaustive treatment from the outset. Rather, I intend to stimulate further research, including empirical studies, and further-reaching fundamental considerations.[3]

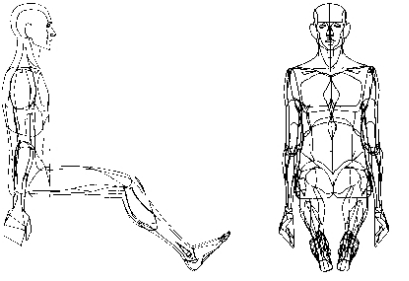
3 In two forthcoming essays, I will present further studies on the topic, namely, an investigation of recent developments in Benjamin Button (USA 2008, David Fincher) and Avatar (USA 2009, James Cameron), and of transformations of the body.

Digital Characters

Historical Overview

Considering the historical development of digital characters, it is fascinating to observe how early attempts were made to grasp and reproduce the human figure by means of computer graphics. We encounter an almost obsessive preoccupation with human characters, whose specifically organic structure so markedly resists digital, computer-based construction.[4]

As a precursor of this development, we may refer once again to the analog version of a computer-generated character, namely, Lee Harrison III's Mr. Computer Image Abc (USA 1968). This simple stick figure was formed from the letters ABC, and was animated by means of an early version of endo-skeletal motion capture[5] (Flueckiger 2008: 145 f.). Until the mid-1970s, the principal computer-generated characters were two-dimensional stick figures, such as those designed by William Fetter for Boeing's flight simulators (see figure 3).

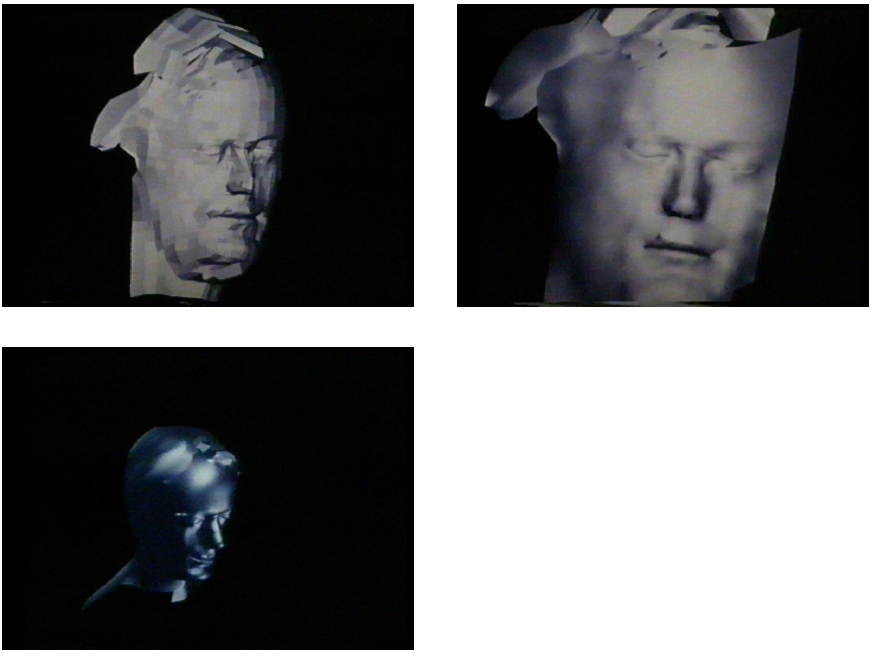


3 Digital character designed by William Fetter (1963)

When Gary Demos and John Whitney Jr. at Information International Inc. (commonly referred to as Triple-I) created a three-dimensional reproduction of Peter Fonda's face for Futureworld (USA 1976, Richard T. Heffron; see Rickitt 2000: 125; cinefex 6: 20f.), this amounted to an incredible quantum leap. Like Fritz Lang's Metropolis (Germany 1927), Heffron's movie concerns an ur-motif of science fiction cinema: the cre-

4 The following discussion of digital characters draws partly on my essay "Emotion Capture. Wie es einer digitalen Figur gelingt, Gefühle zu erzeugen" ("Emotion Capture. How a Digital Character Succeeds in Arousing Emotions", Flueckiger 2007).

5 Motion capture refers to the recording of motion data from an actor to control a digital character. To this end, either optical or magnetic markers are applied onto a suit and their path is subsequently recorded by a camera array (Flueckiger 2008: 145–153).



4–6 Face from FUTUREWORLD with flat shading; face with a smooth surface as Gouraud shading; finally, the same face as a shiny surface

ation of a robot clone modeled on a human being. An animated sequence represents the various stages of development, from a flat polygon version over a smooth surface to a shining, glistening one (see figures 4 to 6).

To achieve this effect, Demos and Whitney applied white make-up to Fonda's face, onto which they projected a grid and then photographed it from two different angles, thereby applying an archaic form of image-based modeling.[6] They used a graphics (or digitizing) tablet to transfer the individual data points from the photographs to three-dimensional space, "giving the computer a database from which it could model the face from any angle" (cinefex 6: 20). According to Sørensen (cinefex 6: 20), when the film came out the spectacular effect was experienced as so perfect that the audience utterly failed to realize the virtuosity of this sleight of hand.

Founded by John Whitney Jr. and Gary Demos in 1974, Triple-I's Motion Pictures Product Group specialized in the computer-generated representation of human characters. In 1981, for instance, they created

6 Image-based modeling: 3D reconstruction of objects from photographs (Flueckiger 2008: 70–77).

a digital replica of an actress for Michael Crichton's Looker (USA 1981) as well as Adam Powers, known as *The Juggler* (who features on the company's 1981 demo-tape). Looker continues weaving the motif of the synthetic double from Futureworld, and technically perfects it by means of 3D body scanning. Looker marks the birth of the so-called synthespian, a synthetic actor.[7] It anticipated a host of characters endowed with the depersonalized, idealized traits of the (male) dream of a female figure, among others Dozo,[8] Lara Croft, Kyoto Date, and S1mone in Andrew Nichol's movie (USA 2002). Just as in Looker, the construction of a digital character is also one of the movie's narrative themes. No strict illusioning of the artificial body occurs, instead representation is framed in technical terms. Réjane Hamus-Vallée (2001: 34) has quite rightly described this as a computational *mise-en-abyme*.[9]

7 The Juggler

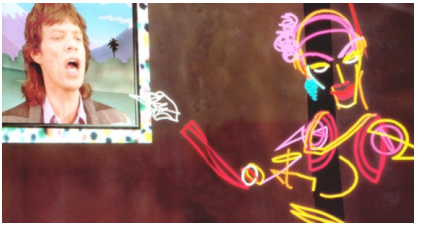
Like Mr. Computer ABC, Adam Powers, *The Juggler* (figure 7), belongs to another development in the history of computer animation, namely, the stylized form as established in the tradition of the classical animation film and situated within a fully animated universe. Adam Powers was

7 Defined by Jeff Kleiser and Diana Walczak in 1988, this term consists of synthetic and thespian (a term used to designate actors, and derived from Thespis of Icaria); see `http://synthespians.net/`.

8 Kleiser/Walczak used motion capture to create an animated singer for the music video Don't Touch Me.

9 Mise-en-abyme: "a textual part reduplicating, reflecting, or mirroring (one or more than one aspect of) the textual whole" (Prince 1987: 53).

designed as a showcase and meant to impress both prospective clients and the computer graphics community. "We thought it would be absolutely necessary to do a human figure," VFX specialist Richard Taylor explained (cinefex 6: 21 f.), "otherwise people would be bound to say: 'Obviously, you can do geometric shapes. But can you do a human being?' Well, we've done a human being. And [...] he juggles." Just as in the Genesis sequence from Star Trek II: The Wrath of Khan (USA 1982, Nicholas Meyer), Triple-I had employed more or less every available technique to present the character in a most spectacular fashion. "He can walk in carrying his head, screw it on, become transparent, turn himself inside out, and do all kinds of things a normal person couldn't do." A Busby Berkeley inspired crane shot was used to further enhance the spectacular staging (VFX supervisor Richard Taylor in cinefex 6: 21). To animate the character, Taylor and his team simultaneously filmed a juggler with two cameras, placed in front of the figure and above, tracked individual points, and loaded their positions into a computerized three-dimensional coordinate system. That is, they extended the procedure developed for Futureworld to the fourth dimension, time, and thus applied a crude form of image-based motion capture. In addition, individual poses were rotoscoped.[10] While the overall impression corresponds exactly to the plastic look common at the beginning of the 1980s, the motion patterns seem astonishingly natural. An irritating gap thus divides gestures from the limited surface parameters – and the complete lack of facial expression further accentuates this gap.



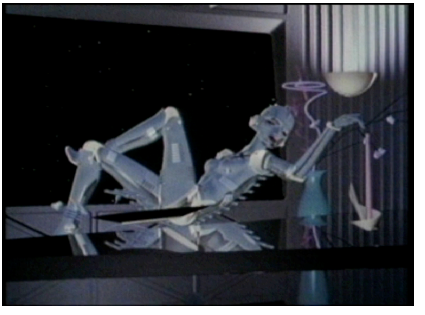
8 Stick figure from Hard Woman, the music video of the Rolling Stones

These early applications spanned a field into which later digital characters could be inserted, at least until the next developmental leap occurred at the end of the 1990s when photorealistic images of the human figure

10 The rotoscope is a device initially patented by Max Fleischer in 1917 for drawing hand-animated sequences based on live-action. Today, the term rotoscope refers mainly to the frame-by-frame extraction of traveling mattes by hand (Flueckiger 2008: 215–221).

emerged. At first, however, the characters remained stylized, mostly abstract reductions of human bodies. In Hard Woman (1986), the music video for the Rolling Stones song, it was a luminous stick figure (figure 8) that was created in 1986 by Brad deGraf, Bill Kroyer, Kevin Rafferty at deGraf/Wahrmann. This character, however, is capable of highly naturalistic and lascivious 3D motion.

Another case in point of this development were the then-trendy wire frame figures designed by Rebecca Allen at the New York Institute of Technology, among others for Musique Non Stop (1986), a music video released by Kraftwerk, the German techno band. All these examples illustrate imaginative approaches to technical limitations, just as the so-called *Sexy Robot* – a mirrored, very feminine, moving robotresse developed by Abel & Associates for the commercial Brilliance (1984; figure 9). Music videos and commercials provided a sort of protected area in which digital characters could be developed according to their own laws, without having to meet the standards set by cinema traditions.



9 Sexy Robot from the commercial Brilliance

In the 1980s, this development was closely intertwined with the progress of motion capture. Its precursor was so-called performance animation, where an actor – partly in real-time – controlled a digital (television) character, such as Waldo C. Graphic or Mike the Talking Head.[11] These characters functioned like digital marionettes, and were coupled either directly or indirectly with the performance of a human actor.

11 Waldo C. Graphic was produced by Pacific Data Image for the television program The Jim Henson Hour (USA 1989), and gave the control unit its name Waldo. Mike the Talking Head was developed by Brad deGraf and Michael Wahrman for demonstration purposes for the new Silicon Graphics 4D Workstation (see Barbara Robertson (1988): Mike the Talking Head. In: *Computer Graphics World*, Vol. 11, No. 7, p. 57; see also Masson 1999: 233, Sturman 1994).

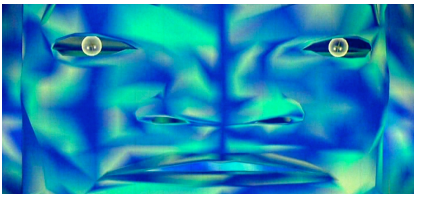
Music videos, television shows, and commercials provided not only sheltered spaces, but they also served as platforms for presenting to a wider audience the research usually hidden in computer graphics laboratories. In 1987, however, one scientific presentation met with unimagined response far beyond the expert world, namely, Nadia Magnenat-Thalmann's and Daniel Thalmann's Rendez-vous à Montréal (Canada 1987, figure 10). This animation film featured digital reproductions of Marilyn Monroe and Humphrey Bogart.[12]

10 Marilyn from Rendez-vous à Montréal

These reproductions raised an alarming foreboding of a post-human cinema that was feared to endlessly recycle and ruthlessly reformulate the achievements of stars long deceased. At the time, this necrophilic idea kindled a far-reaching ethical discourse, which I leave aside here. In Rendez-vous à Montréal, as with many early digital characters, gender differences are strongly pronounced: Bogart's angular movements and face, and Monroe's soft features, into which even small mannerisms of her lip movements have been worked. In spite of state-of-the-art technology, these characters are far removed from their flesh-and-blood models – a fact that Magnenat-Thalmann and Thalmann integrate into their narrative in an ironic fashion.

During the 1980s, only remotely human digital characters appeared in the cinema, for example MCU (Master Control Unit, see figure 11) in Tron (USA 1982, Steven Lisberger), a cylinder bearing no more than an extremely rudimentary resemblance to a human face. Other examples include the stained-glass knight in Young Sherlock Holmes (USA

12 The roughly ten-minute animation film was made at the University of Montreal, and is available online on the Web site of the University of Geneva's MIRALab, directed by Nadia Magnenat-Thalmann (`http://www.miralab.unige.ch`).



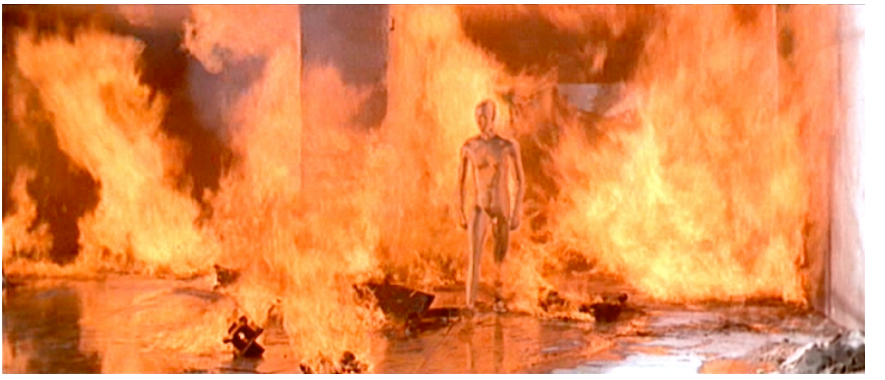
11 MCU from Tron

1985, Barry Levinson), or the water creature imitating Mary Elizabeth Mastrantonio's face in James Cameron's The Abyss (USA 1999).

However, the history of digital characters in feature films only begins in the 1990s with Terminator 2 (USA 1991, James Cameron), The Lawnmower Man (USA 1992, Brett Leonard), and the brief insertion of a digital double in Jurassic Park (USA 1993, Steven Spielberg). Still these characters are strongly stylized – with the exception of the double in Jurassic Park, who makes a fleeting appearance and even disappears in the motion blur. They have glossy surfaces, made of chrome or mercury for the Terminator (figure 12), and of chrome or plastic for the Lawnmower Man and his girlfriend (figure 13). Conceptually as well, these characters make not the slightest attempt to correspond to a natural human appearance, but instead they accentuate the difference and strangeness of the digital creature. Precisely this difference, however, renders apparent the spectacle. Because if such characters seemed perfectly organic and natural, they would remain unnoticed, they would sink into the narration and thus become naturalized.

Given the description of the technological development that I have provided elsewhere as regards modeling (Flueckiger 2008: 51–77) and rendering (172–190), it is obvious that photorealistic, computer-generated characters were still inconceivable at the beginning of the 1990s. Such an objective seemed to lie far off, and many professionals believed that this distant horizon would remain unattainable. The choice therefore was either to narrate stories without computer characters, or to devise narratives that permitted the application of state-of-the-art, yet limited technology. Such spectacular elements were always embedded in the diegesis,[13] however, even if their aesthetic impression was still evidently inconsistent. In The Lawnmower Man – just as in Tron – the parallel

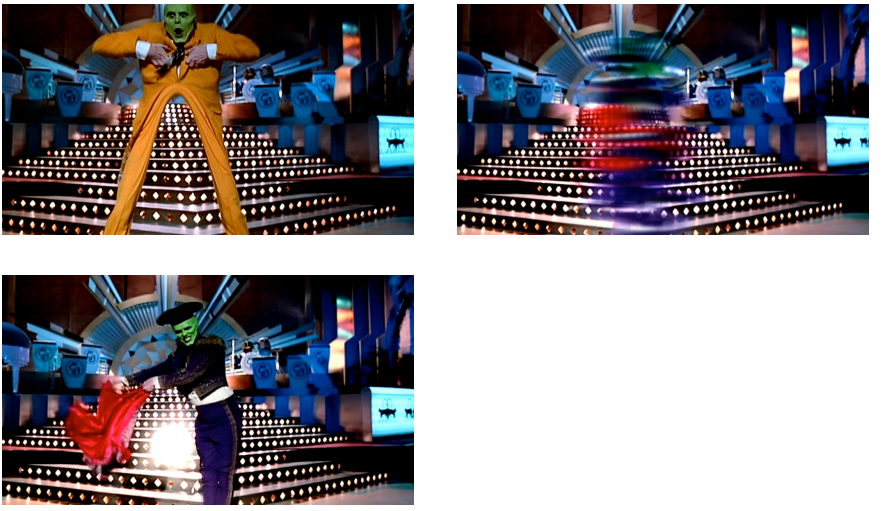
13 *Diegesis* means the space-time continuum of the narrative, that is, the world and time in which the characters live.



12, 13 The terminator T-1000; digital characters in The Lawnmower Man

universe of the computer world is visualized as a virtual reality, the morphing in Terminator 2 blends the character's various phenotypes and smoothes the rupture. Similarly, Disclosure (USA 1999, Barry Levinson) presents diegetic surroundings conceived as parallel universes, in which the digital replicas of Michael Douglas and Demi Moore appear in a brief virtual reality intermezzo. The virtual reality worlds of Johnny Mnemonic (USA 1995, Robert Longo) and Virtuosity (USA 1995, Brett Leonard), which feature digital versions of the protagonists, function likewise. Another example are the Disneyfied little ghosts in Casper (USA 1995, Brad Silberling), two of which have rather human features. Within the scope of the morphing strategy established by Terminator 2, the transformation process in The Mask (USA 1994, Chuck Russell, figures 14 to 16) operates with a "tornado" as a signature effect, in which an everyday character is transformed into a magical phenotype.

CG stunt doubles are another branch of functions for digital characters. Following a brief appearance in Jurassic Park, this branch expands ever further, for example in Judge Dredd (USA 1995, Danny Cannon), where



14–16 Transformation of the character in The Mask; in the transitional stage as a "tornado"; The Mask in its new guise

a digitized Sylvester Stallone rides a motorbike, and in Species (USA 1995, Roger Donaldson), which featured a transformed version of the protagonist in CG, to mention two early but also very trashy B movies. Meanwhile, there are numerous productions featuring superheroes modeled on comics or videogames, among others XXX (USA 2002, Rob Cohen), X-Men (USA 2000, Bryan Singer), Blade (USA 1998, Stephen Norrington), Daredevil (USA 2003, Mark Steven Johnson), and Spider-Man (USA 2002, Sam Raimi). These all seek to transcend the physical possibilities of the human body, or to leave behind the "carbon-based" matter, as Scott Billups, the enfant terrible of digital film, contemptuously referred to actors in an interview with *Wired* (Parisi 1995); in doing so, they enter the almost unlimited field of possibilities of the digital body.

As we will see, this field places quite different demands on the narrative conception of superhero characters. Basically, a fundamental principle for creating suspense is lost if a character can master all dangers. Consequently, the story becomes flat, and audience participation collapses. Closely intertwined with this superhero problem is the role of paratextual[14] knowledge in the pragmatic framework that I have referred to

14 The term *paratext* was coined by the French scholar Gérard Genette (1987). It designates textual information that precedes the reading of a literary text. Similarly, there is information that shapes the viewer's perception of a film, such as making-ofs, reviews, and interviews with directors or actors.

briefly in an earlier discussion of the theory of representation (Flueckiger 2008: 283). If spectators know that the depicted body is nothing more than a pixel cloud, then there is a danger that they will no longer engage in an empathetic relationship with the character.

Parallel to this development, *crowd replication*, or what – following Siegfried Kracauer – we might call the digital mass ornament, emerges from Forrest Gump (USA 1994, Robert Zemeckis) onward. For Forrest Gump, Ken Ralston had still produced analog recordings of the crowds in the baseball stadiums, at the Washington memorial and in China, from which he then furnished 2.5D digital replicas (figures 17 to 19).

17–19 Original scene in Forrest Gump; shot featuring individual groups; final image with replicated crowds

In contrast, Rob Legato's team combined various three-dimensional recording techniques to populate James Cameron's Titanic (USA 1997), among others motion capture, 3D scans, and photographic textures. Based on these recordings, they created a database of fully digital, three-dimensional characters, who could subsequently be further modified and varied. A similar, albeit somewhat more straightforward procedure was applied to create the masses in Ridley Scott's Gladiator (USA 2000; see cinefex 82). *Crowd animation* has meanwhile developed into a highly complex combination of recording and modeling techniques by software such as Massive (figure 20). Using intelligent procedural[15] techniques

15 Procedural techniques are based on general rules that describe complex, often organic-looking patterns of behavior (procedural animation, Flueckiger 2008: 131–144) or geometry (procedural modeling, Flueckiger 2008: 65–69).

20 Computer-generated crowd in Return of the King

linked to ALife,[16] it coordinates the behavior of agents stored in databases (Flueckiger 2008: 139). As in the case of superheroes, crowd animation presents narrative and pragmatic problems.

In recent years, a quantum leap comparable to crowd animation has also occurred in the representation of individual digital characters. These characters no longer only relieve the protagonists' physiques in long shots as digital doubles, and thereby extend their sphere of action into new dimensions, but they have even become principal characters, whose faces can be seen in close-ups. Final Fantasy (USA/Japan 2001, Hironubu Sakaguchi et al.; figure 21) is a splendidly failed milestone in this development. This movie features the first-ever photo-realistically rendered characters in a fully digital animation film – in contrast to their stylized precursors in Aladdin (USA 1992, Ron Clements) or Toy Story (USA 1995, John Lasseter). Following these films came Hulk (figure 22), the Matrix sequels (USA 2003, Andy and Larry Wachowski; figure 23), and Virtual History: The Secret Plot to Kill Hitler (GB 2004, David McNab; figure 24); the latter, a staged "documentary," includes computer-animated reproductions of historical persons like Roosevelt, Churchill, and Hitler.

All these works revealed difficulties, albeit to varying extents. Some of these problems also affected audience participation. However, professionals and audiences alike hailed Gollum, the goblin-like character in The Lord of the Rings who memorably accompanies the protagonists on their journey, as a successful example of a digital character.

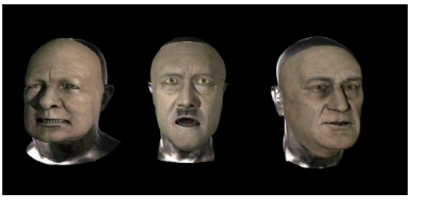
16 Artificial life refers to computer-generated autonomous agents and combines computer science with biology and cognitive science (Flueckiger 2008: 139–141).

21, 22 Final Fantasy; Hulk

In what follows, I will discuss various reasons for this success, and thereby define Gollum as the first convincing digital character in a live-action movie. Based on insights from my investigation of the technology and the theory of representation, I will first consider some fundamental problems of digital character construction before attempting to systematically discuss the technical methods involved, and subsequently proceeding to illustrate the interrelations between aesthetic, narrative, and emotional aspects of characters and the audience's response to them.

Fundamental Problems of Digital Character Construction

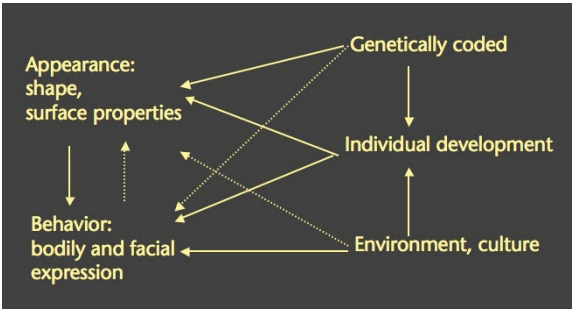
During our lives, we become highly skilled at decoding body language and facial expressions. From infancy, we train our perceptual system to recognize and interpret human behavior: our interlocutor's non-verbal signals play a decisive role in the process of understanding in all communicative situations. We therefore learn to discern the most subtle nuances, especially of facial expression, to be able to detect those fine distinctions between a genuine smile and a false one, for instance.



23, 24 Agent Smith's computer-generated face; computer-generated historical persons in Virtual History

In our living environment, the individual information units of body language and facial expression interrelate in a systemic way to form an overall impression. For the purpose of analysis, this impression can be divided into two categories: *appearance* and *behavior*. Appearance, furthermore, consists of the parameters *shape* and *surface characteristics*.

Appearance and behavior are interrelated in a complex network based on genetic information on the one hand, and on environmental and cultural influences amidst which individuals grow up on the other. This approach is indebted to the dynamic-interactionist paradigm of personality psychology, which assumes the intimate reciprocity between individual and environment (Asendorpf 2004: 84 ff.). This model further assumes diverse interactions, in which environmental influences affect biological processes of human maturation while individuals also shape their environment through selection, production, and change.



25 Dynamic-interactionist conception of personality

Individual development is of utmost priority in this network (figure 25). Appearance is defined chiefly by the genome. As mentioned in the introduction to this essay, its secondary characteristics like clothes and hairstyle form a higher-order symbolic system determined by cultural

codes. While this symbolic system attracts no particular interest in the psychology of personality, fictional cinema attaches essential importance to its expressive function. Both factors – nature and nurture – are similarly active in human behavior, since some forms of behavior are caused by congenital programs while others arise from adaptation to cultural rules. Further interdependencies exist between appearance and behavior. For instance, a corpulent figure moves differently than a small, thin one, or muscle structure results largely from particular motion patterns and acts back on these.

Appearance and behavior are only loosely connected in fictional cinema. Actors lend characters their bodies, and attempt to bridge the gap between body and behavior through interpretation. Indeed, two bodies are hence often referred to: first, the actor's body; and secondly, the filmic body. Manifold connections can be established between these bodies, which are also shaped by both textual and intertextual, extradiegetic influences. "The body's image is the character's sensory material basis," while the cinematographic body image is a priori "an aesthetic and social construction possessing a physical-psychic expressive potential" (Taylor/Tröhler 1999: 139). It is formed by various processes of semantic modification, which I have partly discussed elsewhere with reference to Tom Hanks as Forrest Gump in the context of the theory of representation (Flueckiger 2008: 300). Among others, these processes are determined by the specific human-machine interaction of the filmic representation of the body, and furthermore by an actor's individual story – his "extradiegetic existence" (Weingarten 2004: 22) – and also by an intertextual semantic field that reflects the actor's representation of previous film characters.

While this connection is already complex and potentially fragile in fictional cinema – miscasts such as Tom Hanks as the Harvard professor in Ron Howard's The Da Vinci Code (USA 2006) come to mind – , digital character construction presents even far more demanding challenges. If a character should be perceived as an entity, he or she has to develop his or her own specific consistency within the representational and narrative aspects of fictional character conception, which Murray Smith refers to as a person schema (1995: 110). To build such a consistent schema in CGI, a multitude of fragmented features must be integrated into a super-ordinate structure during modeling and animation. Except for some few procedural ALife systems, which are until today only able to bring forth some very simple creatures like fish (Flueckiger 2008: 139), both appearance – involving shape and surface characteristics – and behavior are often created separately through divided processes. But if the characteristics of appearance and behavior disintegrate into their components with no

plausible connections between them, no unified character possessing individual traits will result. It becomes difficult to attain the audience's emotional participation, since establishing a relationship with the depicted person is essentially linked to a perceived identity. Morphing characters – like the T-1000 in Terminator 2, the agents in The Matrix, and Mystique in X-Men – are so disturbing precisely because they stir up this notion of identity.

In addition to character consistency, the second fundamental problem concerns the modeling of complexity, which I have discussed in detail from the perspective of the theory of representation (Flueckiger 2008: 317). As shown there, complexity always arises from a history. While stochastic and fractal algorithms are capable of producing complexity, specifically the complexity of plants or landscapes, the creatureliness of the human figure belongs to a different order, whose specific complexity is characterized by phylogenetic[17] and ontogenetic[18] development, through which individual distinctiveness is established. This wealth of detail places particularly exacting demands on digital character construction.

The human face – eyes, mouth and nose, eyebrows and hair – consists of a multitude of minute and yet essential elements. Who thinks of the *caruncula lacrimalis*, the small, pink nodule at the inner corner of the eye between the tear dots? Furthermore, the eyeball is not a smooth sphere but instead slightly irregular, bearing small elevations and depressions that transform reflected light into a sparkle that differs from a plain, specular highlight (see animation supervisor Colin Brady in cinefex 94: 98). Each eyelash, like every single hair, is an individual object with complex motion patterns, just as the human mouth comprises many single elements: the lips with their small furrows, or the teeth and tongue, and so forth. One of the most demanding materials to be modeled and textured is human skin, whose layered structure and specific reflectance behavior until recently eluded satisfactory results.[19] It does so since it is semi-transparent, and in some places dull, while reflective in others. Through complex *subsurface scattering* (Flueckiger 2008: 100), light rays penetrate the skin and acquire the color distribution of the underlying structures. No single skin shader unites all these properties, but instead complex shader networks must be designed, sometimes using hundreds of maps that reproduce this

17 Phylogenetic: in the course of the evolution of mankind.
18 Ontogenetic: in the course of an individual's development.
19 Most recently, there has been another advance in skin modeling, as seen in Benjamin Button.

reflectance behavior. I will discuss these features in detail later, and also present various skin modeling methods.

Given that these anatomical elements are so extremely difficult to model, the complexity increases exponentially as soon as a character moves. For example, hair animation – like all materials whose appearance is closely connected to their temporal behavior – remains most demanding to this day. Precisely this complexity makes it both interesting and enlightening to explore the various computer procedures used to construct human figures. Hardly any other field better reveals the problems of computer animation, and thereby provides insight into some of its underlying conditions.

The third fundamental problem of digital character construction is the interaction between digital characters and other characters, and between such characters and the specific terrain and props. I have discussed this problem exhaustively in the context of compositing, specifically from the point of view of spatial and movement adaptation (Flueckiger 2008: 239), as well as in regard to touch, gazes, and physical interaction (249). Such interaction has utmost significance for the deeper layer of audience participation, since the empathy evoked by characters is evaluated not least in terms of their position within the group (Wulff 2003: 139). Obviously, not only the physical and verbal aspects of a scene determine this interaction, but it also fits into the larger textual network of multi-layered narrative construction.

Technical Procedures for Character Construction

shape	3D polygon	3D scanning	image-based modeling
surface properties	painted textures and shaders	photographic textures and shaders	
animation	keyframe	motion capture	rotoscoping

26 Overview of character construction methodologies

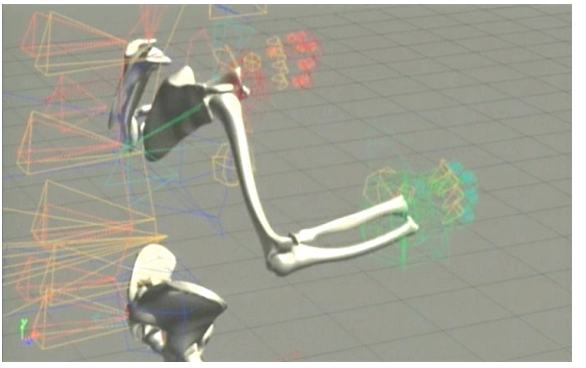
Based on the classification system established in my discussion of recording and model building, painting and measuring elsewhere (Flueckiger 2008: 289 f.), I have created a matrix that allows us to systematically

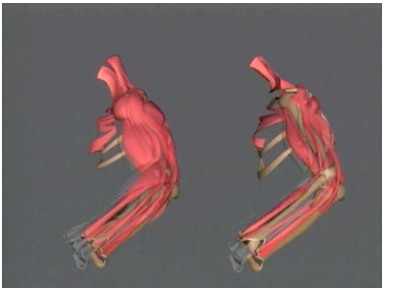
identify the various methodologies of character construction.[20] In the following table, the various categories are color-coded as follows: yellow for model building, blue for recording, and green for painted elements. All techniques used for character construction can be projected onto this table. This enables a systematic discussion of the interrelations between technical, aesthetic, and narrative aspects.

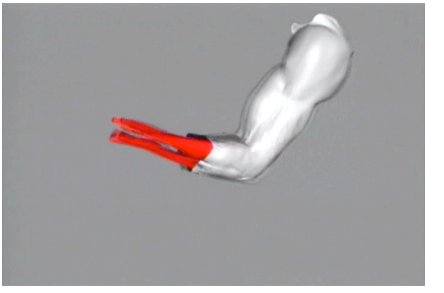
Shape 1: 3D Modeling

When it comes to creating a (fantastic) character, for which nature provides no example, its shape must be modeled. During the initial, conceptual phase, and based on the description in the literary source or the script, usually hundreds of concept drawings and clay maquettes are produced. They process a vast array of influences and are further developed until they consolidate into a definite tangible shape. Traditional, manual modeling thus often precedes 3D computer modeling. A next step usually involves producing a 3D scan of the clay maquette, in order to import its basic form into the three-dimensional coordinate system where it is further refined and endowed with a skeletal and muscular system (figures 27 and 28).

20 In my research on the different technical strategies and their epistemological foundations, I have devised three basic modes, namely, recording, painting, and modeling. A fourth one is measurement, which usually plays a minor role. Measurement means the gathering of explicit data, for example to reconstruct objects or architecture in the computer. – By recording I understand the translation of a physical structure according to an implicit or explicit protocol. We can assign digital photography to this category, but also motion capture as the recording of motion data in a 3D space. These approaches gain increasing importance when complex structures of the real world are to be imported into the 3D space of CGI, most prominently so in the construction of digital characters. – Painting refers to image generation and processing with emulated tools such as brushes and pens. It is used in CGI, for example in the creation of texture maps which describe the colour distribution on the surface of objects. – Model building ("Modellbildung") is a dominant practice in CGI. It is a rule-based, explicitly formalized system to generate 3D objects and animations. The rules apply either mathematical or physical principles or stem from empirical observation and reconstruction. Typical examples of such modelling processes are procedural animations of flocks of animals like birds and crowd animation (Flueckiger 2008: 131 et seq.). Furthermore, procedural approaches include the modeling of landscapes and plants based on algorithms from fractal geometry – for example the L-systems by biologist Aristid Lindenmayer that apply the formal grammar of plant growth (Flueckiger 2008: 65 et seq.). And finally, all the rendering algorithms that calculate the interaction of light with the objects to provide the final image of a 3D scene are all based on model building (Flueckiger 2008: 101 et seq.). By their very nature models are simplifications of complex phenomena. They suppress those details which are deemed unimportant, or they work with shortcuts that simply deliver the required results while neglecting some further aspects.







27–29 Skeleton structure from The Mummy; muscles; skinning

The skin is then laid over this geometry – in a process known as *skinning* (figure 29). Skin behavior has to be connected to the underlying skeletal and muscular structure in either closer or looser alignment with the requirements of the human anatomy. Meanwhile skinning systems are so advanced that they not only enable wrinkling, but also allow the skin to glide over the underlying structure. In Gollum's case, 700 muscles were created in slight divergence from the human anatomy to facilitate his characteristic motion patterns; the skeletal system also permitted both forward and inverse kinematics (see the comments of creature lead Eric Saindon in cinefex 92: 85; Flueckiger 2008: 123).

Shape 2: 3D Scanning

3D scanning is used in various cases: whenever the aim is to create a completely human character using a computer; whenever an actor is meant to feature on a computer screen as a digital replica like in Looker or S1mone; whenever an actor's body must be morphed either seamlessly or visibly into a digital double like in The Mummy, Hollow Man, or like the Borgs in Star Trek: First Contact (USA 1996, Jonathan Frakes); in

short, 3D scanning is applied whenever a digital version must look either especially photorealistic or refer to an existing body. In contrast to modeling, scanning is a recording technique that captures existing complexity in full detail. It is capable, moreover, of representing an individual body fully endowed with all the features of a real existence. However, it fails to grasp the underlying structure, which must be created as a skeletal and muscular structure just as with modeling. This requirement applies mainly to bodies whose skin is damaged and, by implication, allows us to see this structure, such as in Virtuosity, The Mummy, or Hollow Man. It applies furthermore to characters who suffer a bizarre death, such as in Resident Evil (GB/Germany 2002, Paul Anderson) or in Cube (Canada 1997, Vincenzo Natali), where bodies are disassembled by laser rays, and finally the exploding bodies of the vampires in Blade.

Shape 3: Image-based Modeling

Image-based modeling techniques (Flueckiger 2008: 70 et seq.) are capable of recording all geometry and surface details both simultaneously and comprehensively. To the best of my knowledge, the characters in David Fincher's Fight Club (USA 1999) were the first applications of this technique: Marla in their sex scene, and the protagonist in the suicide scene, were both filmed by an array of cameras. Usually, an additional 3D scan is produced to obtain more precise information on form, a procedure called explicit image-based modeling.

Image-based modeling has been constantly and successfully developed since its inception, because if digital doubles are meant to be seen in close-up, this technique delivers by far the best results. Even more comprehensive techniques are being applied, including *Universal Capture*, used for The Matrix sequels, or *Light Stage*[21] (figure 30), developed by Paul Debevec and his group which for instance was employed to transpose the characters in Spider-Man 2 (USA 2004, Sam Raimi) into the digital domain (Flueckiger 2008: 164). *Light Stage* enables the recording of surfaces under different lighting conditions, as created by diodes in the three primary colors (red, green, and blue).

Light Stage is used to photograph surfaces not only as texture maps, but also to record their reactions to light. While this technique produces absolutely photorealistic results, it is quite elaborate, thus prompting CG

21 Lemmon, Dan (2001): Image Based Lighting, High Dynamic Range Images, and Global Illumination in a Production Environment. In: *SIGGRAPH*, 2001, Course No. 14, Image-Based Lighting, pp. 17 ff. (`http://www.debevec.org/IBL2001`); see also Reinhard et al. (2006: 454) and the version Light Stage 6: `http://www.fxguide.com/article363.html`.

30 Long exposure of the Light Stage

supervisor Peter Nofz (in Robertson 2004: 6) to predict that it will have become obsolete as soon as improved subsurface scattering techniques exist: "Ultimately, math will win over photography."

All image-based techniques strive to simultaneously capture most parameters of the represented character to achieve the above-mentioned character consistency and its entire network of internal relations as completely as possible in the digital domain. Apart from facial animation, which I will discuss below, in these capturing systems motion patterns must still be recorded separately or animated manually, since the actors are placed rigidly at the center of the camera array or the Light Stage, and are unable to move their bodies during recording.

The application range, moreover, is relatively narrow, since only real bodies[22] can be recorded, and only exactly the way they look. Visual effects supervisor Dennis Muren has therefore questioned the sense of a technique capable of capturing all parameters, since one might just as well apply traditional filming techniques (see cinefex 100: 77). All these image-based processes aim at grasping the photorealistic impression precisely, while at the same time extending the scope of action in a play between similarity and difference. In the above-mentioned suicide scene in Fight Club, the protagonist's head was meant to explode in close-up while the bullet was entering his skull – preserving the actor's natural

22 Recently, silicon maquettes were captured for Benjamin Button on the Light Stage to provide reference material for the shaders (cinefex 116).

face, whose corresponding reaction was triggered by an air blast occurring at the center of the camera array.

31 The super toddler in Lemony Snicket

In Lemony Snicket's a Series of Unfortunate Events (USA 2004, Brad Silberling), some of the tough super toddler's behavior becomes possible only because the twins playing the role were digitized using a proprietary image-based ILM system (cinefex 100: 142 ff.); likewise in Spider-Man 2, where Light Stage was used to record the villain Dr. Octopus, whose digital tentacles clearly transpose the character's motion patterns into the non-human sphere. Finally, visual effects supervisor Joel Hynek (cinefex 100: 77) considers whether studios and insurance corporations should not demand a digital copy of their actors – as a warranty in case of death...

Skin

Human skin, as mentioned, is one of the most complex materials. It notoriously resists computer generation, since it comprises manifold layers and features, each requiring individual definition during modeling. These surface characteristics are composed of painted, computed, or photographed texture maps. Texture maps describe the complex color distribution of the skin surface, while displacement or bump maps represent the small-scale geometry of pores, wrinkles, and scars; specularity, reflection, and diffuse maps characterize the skin's reaction to incidental light (see chapter "Shader" in Flueckiger 2008: 88 et seq.). Likewise, classical painting

considered representing the human skin most challenging. As Kebeck (2006: 183) observes, true mastery became evident in the differentiation of nuances, which, for example, distinguish healthy from sick skin. On account of these difficulties, many digital characters were and still are squeezed into tightly fitting all-over bodysuits made of leather, metal, or plastic, thus requiring less skin modeling.

Given the problems involved in reproducing the skin, hybrid processes are the rule. One exception is the above-mentioned image-based technique, which records all details including light reflectance on Light Stage with the exception of highlights. As CG supervisor Peter Nofz has noted, "With this system, the question of whether the skin looked right or not went away. This is his skin, it looks right right away" (in Robertson 2004: 3). Other exceptions are painted maps, which are used to create the skin of more strongly stylized characters like Shrek or Hulk. However, even such stylized skin rendering normally starts from a sample of photographed texture maps. Displacement maps and bump maps, which feature the numerous skin's elevations and depressions can be produced using high-resolution 3D scans (Flueckiger 2008: 87). This technique was used for the Matrix sequels and for Gollum, for instance, where they were partly extracted from high-resolution 3D scans of the clay maquette. When digital replicas of familiar characters are to be created, such as digital doubles or to a lesser extent historical figures, it requires the most precise reproduction of all details. Among others, it included Laurence Fishburne's characteristic acne scars for the Matrix sequels or Hitler's slightly grayish tear sacs for Virtual History.

Until recently, the greatest barrier to computer-generated skin has been its semi-transparency, the so-called translucency (Flueckiger 2008: 100), because it requires the rendering of subsurface scattering to provide convincing results. While Jensen (2001: 127 ff.) has developed a technique for modeling this effect, many visual effects specialists avoid it because it is very data-heavy. According to visual effects specialists, genuine subsurface scattering was applied, among others, in XXX (cinefex 92: 49), in Daredevil (cinefex 93: 34), and in Big Fish (USA 2003, Tim Burton) for the décolleté of the Siamese twins (cinefex weekly update 17: 3). Much more often, however, visual effects artists resort to various tricks to avoid computing this effect, but to imitate it instead. While working on Gollum's skin, prosthetics supervisor Gino Acevedo transposed his layered airbrushing technique, which he normally used to control the skin translucence of silicon models, to the computer world, notably under the supervision of a whole crew of technical directors. He was enthusiastic about the process: "I've got all my favorite colors, they never run out, and

they never spill. I told the guys at Digital, if they could just put a couple of vents on the side of the monitor and blow toxic fume in my face, it would be perfect" (Acevedo in cinefex 92: 89). In this case, not real skin, but instead artificial, prosthetic skin served as the frame of reference. Painting in layers dates from oil painting, where semi-transparent washes are applied on a foundation until a convincing effect has been accomplished. Similar techniques were employed using ViewPaint to create Hulk's skin:

> 'Hulk looked like Play-Doh if we made him simply green,' observed [Viewpaint Lead Susan] Koch, 'so we added [...] underlying colors, which really made him look alive.' Hulk tissue was ultimately comprised of a green-pigmented dermis with red flesh underneath, combined with subtle hues of yellow.
>
> (cinefex 94: 86)

Ultimately, Hulk's skin consisted of a hundred layers, organized in complex shader networks. Approximately 12 000 maps were created to this end, since one must be able to modify individual maps depending on the animation, whereby complexion alone constitutes an expressive means. "No believable facial rendering can be done without varying the face texture over time" (Borshukov et al., Universal Capture, 2003).

Dirt, water, fat, and sweat can be superimposed on the skin according to a given situation, thereby determining its appearance even further. Again, specific shaders must be defined, and these in turn consist of a series of superimposed maps.

Thus, computer-generated skin is not only a technical obstacle that needs to be overcome, but it also provides rare insight into the modularity of the processes, as reflected in a complex network structure of individual, nuanced features.

Body Animation 1: Keyframe Animation

Keyframe animation ranks as first choice for the animation of magical or superhuman motion sequences (Flueckiger 2008: 119 et seq.). Typical examples include the superheroes in X-Men, XXX, Daredevil, and Spider-Man. Thus, visual effects supervisor Rich Thorne observes that Daredevil was supposed to seem totally human: "Mark Steven Johnson didn't want to put Daredevil into any situation that a very strong, very gutsy human couldn't handle" (cinefex 93: 30). Nevertheless, motion capture was rejected, as VFX supervisor Derek Spears explains: "The consensus was that motion capture was not going to give us exactly what the director wanted" (cinefex 93: 31). After all, the character was supposed

to plunge into the deep off a forty-storey building – a feat that could not be adequately recorded with motion capture. Moreover, it exceeded the abilities of even a well-trained athlete. I will discuss this issue below in the context of the superhero problem.

Even in film productions basically committed to motion capture, some instances call for keyframe animation. One case in point was the creation of the digital masses aboard the Titanic. In TITANIC, Rob Legato and his team first tried to have stuntmen perform the jumps from the bursting steamboat. But following several accidents, keyframed versions had to be resorted to. If the characters were going to crash onto ship parts several times and ultimately be crushed to pulp by the ship's screw, such motion patterns could not be recorded by motion capture (cinefex 72: 73 f.). Hulk was a similar case, where procedural animation such as rigid body dynamics were intended to ground his flight trajectories in physics. Gollum also involved situations for which neither rotoscoping nor motion capture could be used, but he instead required keyframe animation.

Plausible looking results presuppose the above-mentioned skeletal and muscular structure as well as other physical parameters able to account for body mass in particular. Keyframe-animated bodies often seem too lightweight, and their movements are too harmonious due to interpolation curves. Because the hypothetically limitless scope of keyframe-animated motion allows for the transgressing of the physical laws of the real world, detached ballet interludes high above the roofs of Manhattan have moved within closer reach. Any comic-strip pose can make its way onto the screen, or as LaMolinara remarks on SPIDER-MAN: "As an animation director, I am ready to push the character as far as it can be pushed" (cinefex 90: 21). Moreover: "Sometimes that means 'breaking' the character. Physiquers like to put limits on, and we like to turn them off! [...] the animators and I always wanted the pose to 'sing', to shine."

Body Animation 2: Motion Capture

Since the beginning of computer-based character animation, motion capture has been considered the ideal technique for endowing animation with personality, as highly work-intensive keyframe animation also entails extensive division of labor. Thus, character consistency is threatened by a dissolving of the expressive behavioral repertoire. Nevertheless, it seems by no means self-evident that only one single actor performs the necessary movements on a motion capture stage, quite unlike Gollum's case, where Andy Serkis played the character single-handedly, namely twice: once on the set in direct interaction with his companions Sam and Frodo, and

secondly on the motion capture stage. Acoustic cues – either dialogue parts or abstract electronic sounds representing individual actions – were used to control the timing. Animation supervisor Randall William Cook thus observes: "Mocap is only as good as the 'mo' you 'cap' – and fortunately Andy provided some terrific 'mo'" (cinefex 90: 92). Just as in many other cases, the proportions had to be altered, because Gollum's physique was evidently different to Andy Serkis's, making it necessary to compute offsets of the individual points using a complex transfer technique – as far as possible in real time, so that director Peter Jackson could immediately assess the acting quality on his monitor.

Motion capture has meanwhile become the standard procedure for animating characters whose motion repertoire is oriented toward the laws of the real world. It was first applied to the burning priest in The Lawnmower Man. The technique was also used to animate the dissolving mummy in The Mummy, based on Arnold Vosloo's representation, or to animate individual Romans on the physically absent textile awning covering the arena in Gladiator; all movements in the fully computer-animated Final Fantasy, many movements in Hulk, and those parts of the robotic movements in I, Robot (USA 2004, Alex Proyas) that were meant to occur within the reach of human motion patterns were also transposed onto the robots by means of motion capture.

Body Animation 3: Rotoscoping

Rotoscoping, a preliminary form of motion capture, has largely lost its significance for animation (see footnote 10 and Flueckiger 2008: 215). It is chiefly used to eliminate proxies[23] (Flueckiger 2008: 256) from the background – such as in Hollow Man, The Lord of the Rings, or I, Robot. In all these movies, a hybrid technique was used, referred to by technicians as *rotomation* (cinefex 96: 69). Here, a proxy is first detached from the background, and secondly, based on the proxy's performance, the digital character is inserted into the image. Its movements were reproduced using motion capture combined with keyframe animation derived from the proxy's movement. More closely modeled on the idea of rotoscoping was the transposition of facial expression from the proxy onto the digital character. I will discuss this topic in the context of facial animation.

23 *Proxy*: actor who plays the part of a digital character on the set, such as Andy Serkis for Gollum or King Kong.

Facial Animation 1: Keyframe Animation

All requirements concerning body animation are greatly exceeded by facial animation, since the face is probably the densest surface, possessing an enormous number of subtle movements. Such nuances are tremendously significant in our experience of the world. In audiovisual communication, especially in film, close-ups contain moments of utmost concentration on the face that are decisive for audience participation (see Plantinga 1999: 239 ff., and various contributions to Blümlinger/Sierek 2002).

In recent years, a methodology for facial animation has emerged that is based on and elaborates insights into the universality of facial expression, as described especially in the psychological and anthropological studies undertaken by Paul Ekman et al. in the early 1970s. Ekman drew on the claims that Charles Darwin had advanced in *The Expression of Emotions in Man* (1872), especially concerning their biological foundation.[24] Ekman's idea was to divide facial expression into discrete units, related to the muscular structure. In the late 1970s, he developed his approach to the so-called *Facial Action Coding System (FACS)*.[25] FACS systematically categorizes the interrelation between the activities of the muscular system – comprising forty-four action units – and the six basic emotions (happiness, surprise, sadness, fear, disgust, and anger). By no means does this system only integrate schematic positions of the fundamental emotions in their purest form, but it also involves composites and subtle transitions. Other aspects of facial expression studied by Ekman et al. were culturally conditioned display rules and dissonances between experienced emotion and facial expression to conceal inner states, such as in lying. Thus, the system is at the same time highly complex and yet clearly arranged, and therefore exceptionally well suited to implementation in facial animation by the computer.

Now two fundamental possibilities for interpreting such a system exist. The first is limited to surface changes, while the second actually builds up a muscular system analogous to the facial anatomy, to which the skin is linked with a procedural system. Many systems, however, at first model the basic elements of facial expression in one way or another – for example, the eyebrows or eyelashes in different forms – as *morph targets* or *blend shapes* (Flueckiger 2008: 121) stored in a database. Additionally,

24 For a comprehensive discussion of all aspects of facial expression, see Bruce (1998).

25 Numerous texts on FACS, as well as some illustrations, are available on Joseph Hager's Web site, one of Ekman's collaborators at the time; see `http://face-and-emotion.com`; for a Flash-animated muscle structure, see http://www.artnatomia.net/uk/index.html.

they define controls for transferring these morph targets into one another. Such morphing, from one position to another, can be undertaken almost seamlessly, quite similarly to FACS.

Scientifically grounded FACS was not used for Gollum, however, but instead Gary Faigin's *The Artist's Complete Guide to Facial Expression*; as its title implies, this approach leans more toward art than science. Directed by creature facial lead Bay Raitt, a team of animators modeled 675 typical facial expressions – based on 9000 forms of muscles (cinefex 92: 85). Using a system that Raitt refers to as "combination sculpting," it was possible to connect the distribution of the skin to the flexible sub-surface geometry, notably within a predefined framework of expression designed to support character consistency (Raitt in Serkis 2003: 77 ff.). Applying this system allowed for securing and blending certain combinations of expressions. "Gollum wasn't the kind of character where we could sculpt a pose, bend that and call it a performance," as Raitt comments on his approach (cinefex 92: 80). He further asserts, "He needed to be able to cry, to have his whole face in complete compression, then to be able to act from there." The animators had to use and check this expressive repertoire in real time; Raitt and his team therefore worked with a gaming program, which, like a video game, enabled intuitive, real-time control. Following Peter Jackson's instructions, who wanted to align Gollum more strongly with Andy Serkis's physiognomy, various basic expressions – all interpreted by Serkis – were scanned (cinefex 92: 80).

A second animation system, based on a similar approach, served speech articulation. Adopting customary procedure (see Kerlow 2004: 358 f.), Raitt and his team first created a database comprising the individual phonemes or rather *visemes* – the visual formation of phoneme articulation. Subsequently, they systematically organized the audiovisual relationship between the shape of the mouth and a given sound, applying three "golden rules": first, all phonemes occurring in a dialogue were written down; secondly, not every phoneme should be rigidly attributed but phonemes should be allowed to blend, placing particular emphasis on plosives; and thirdly, the image should be moved forward by two frames to better align image and sound (Raitt in cinefex 92: 85).

The true art, however, only begins afterwards, since timing, transitions between poses, and the involvement of the individual parts of the face are all essential for coherent facial animation. Keyframe-animated faces run the risk of seeming sluggish, too slowed down, and not vivid enough. Small movements, so-called micro-expressions, can be detected in even the most stoic faces. Studies have shown that changes can occur within tenths

of a second (Schneider 1990: 429), and that timing is itself significant (Bruce 1998: 191).

Just as critical, if not even more critical, are the transitions between poses, since they do not occur in a coordinated fashion but shift permanently against each other. A blinking eye, a slightly puffed up cheek, somewhat asymmetrically opened lips: such minimal details are extremely difficult to keyframe-animate. Ultimately, facial expression is interpreted holistically, as an interplay between all involved elements, in which the divergences can become especially important, as we all know. Thus, we notice a person's insecurity because suddenly their eyelids start flickering slightly. Therefore, animators must possess profound knowledge in combination with a highly differentiated imagination. Even then, however, the fundamental problems remain, as discussed in my earlier account of model building (Flueckiger 2008: 316 et seq.). Missing are those accidental disturbances of all too smooth, all too conceived processes. Commenting on Anthony Hopkins's reduced, stoic performance in The Remains of the Day (GB/USA 1993, James Ivory), VFX supervisor Richard Edlund observes: "Just think how difficult that would be to animate" (cinefex 100: 73).

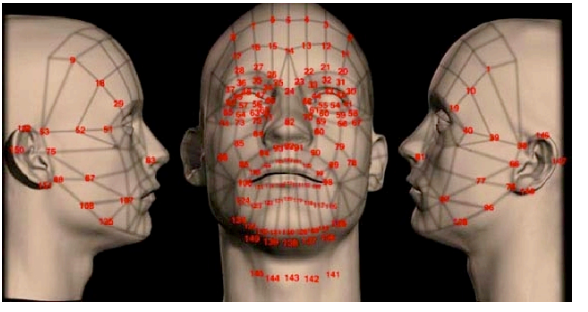
Facial Animation 2: Facial Motion Capture

More or less parallel to the highly developed process of facial keyframe animation, a motion capture technique has been developed for the recording of facial expression. Like in body motion capture, small markers are distributed on the face and photographed with an infrared camera array from different perspectives. In a slightly modified form, used for example in Virtual History, colored dots were painted in accordance with a grid projected onto the face. These painted or applied points correspond to significant facial details, for example the inner or outer corners of the eye, the upper and lower rim of the eyebrows, and some crucial muscle attachment points when working with a muscular system.

Usually, as with Virtual History, the actors are stuck on a chair and mime only their dialogue and their facial expressions. Obviously, this approach severely constrains an actor's expressiveness, just as dubbing at the lectern restricts vocal expression. Because facial expression and body movements interact with each other, the face changes with concurrent body movement. Moreover, it is very difficult to retrospectively align facial and body movements. "Anything from a head turn to footsteps, from walking to running, are all extremely difficult to line up if the face and body aren't captured together" (SIGGRAPH 2005, Course No. 28: 23).

For all these reasons, the Sony Pictures Imageworks team directed by Ken Ralston developed an integrated approach for The Polar Express (USA 2004, Robert Zemeckis). Referred to as *performance capture*, this technique enables the simultaneous recording of facial and body movements. While the results strike me as unconvincing, for reasons still to be considered, I will introduce this technique starting from this example, based on the 2005 SIGGRAPH course (Course No. 28, 2005) and on additional details published in *cinefex* 100. Initially, a similar system was planned for Gollum, with black dots on Andy Serkis's face. However, the idea was discarded because the technique was not considered sophisticated enough.

For The Polar Express, technicians applied 151 facial markers, each with a diameter measuring 2,4 mm, according to a predefined schema (fig. 32) – in contrast to the usual systems, which merely rely on 30 to 60 markers. Due to the extreme flood of data resulting from the combination of facial and body recording, merely small segments could be recorded, thus requiring the segmenting of all shots into smaller units. While this approach ensures the unity of body and facial movements, the segmentation confines expression in another way. To track marker movements, a tracking software was used to first extract head movement, that is, the head was computationally stabilized and mapped onto the digital face.



32 Facial markers in The Polar Express

The eyes presented a particular problem. Although Kerlow (2004: 360) mentions special contact lenses to capture eye movements, Ralston's team omitted the eyes and retrospectively keyframe-animated them. The "eye problem" was exacerbated by a fundamental problem of facial motion capture, namely, noise caused by the minute markers disappearing in the eyelid crease. In sum, the system had to struggle against strong occlusions,

precisely because the markers were so tiny. Consequently, it produced grotesquely distorted expressions from minimal offsets. Ultimately, the eye markers could at best be used for timing the blinking. The line of vision, eyes, and eyelids were connected in a complex dynamic system where the eye area followed the eye with a delay caused by the viscosity of the tear film. "It took a lot of time to create an emotional connection with the characters," Ralston admitted (cinefex 100: 125), "and the eyes were key to making that believable. I'm not a minutia guy, but I had to become one for this film." Ultimately, it was even a matter of reproducing saccadic eye movements, followed by a brief fixation phase. "When we coupled that with eye-shape changes and lighting, we started to see thought," as animation director David Schaub described the effect (cinefex 100: 126).

In many cases – but perhaps less frequently than usual – motion capture had to be replaced with keyframe animation, especially when adults were playing children. Since all motion capture sessions were also recorded by several video cameras, these recordings served as reference.

In *cinefex* 100 (75 ff.), many visual effects specialists raise fundamental doubts whether facial motion capture is a viable solution and produces satisfying aesthetic results. Animation director Andy Jones, for instance, who tested such a system for Final Fantasy, remarked that "no matter how many markers you put on the face, you're still filtering the movement of the skin – and it looks like that" (cinefex 100: 75). The distribution of dots is too rough, thereby always leaving gaps; credibly filling these gaps is difficult to impossible when a face is seen close-up in photorealistic rendering. Within the motion capture approach for the recording and transposition of an actor's facial expression, practitioners only see a chance in image-based techniques that enable total pixel flow. One such system is universal capture (Flueckiger 2008: 75) or the mentioned Light Stage.[26] A similar system was developed for years by VFX supervisor Hoyt Yeatman for a film that was never shot (Gemini Man), and then ultimately discarded by Disney.

Facial Animation 3: Rotoscoping

While the face is no longer rotoscoped in the literal sense, the term nevertheless applies to facial animation following the actor's interpretation as with Gollum, whose mimic expression was based on Andy Serkis's

26 Recently similar processes were applied in Benjamin Button and Avatar; for Benjamin Button Image Metrics Performance Capture with an array of Viper high definition cameras (cinefex 116: 79 et seq.) and for Avatar a performance capture system based on a standard definition helmet camera (cinefex 120: 82 et seq.).

performance. Certainly some technical requirements are necessary for such a transfer, including a perfect structure of the face and an intuitive keyframe animation system with an appropriate morph target database. In the case of Gollum, the task was even more due to the marked differences between Andy Serkis's and Gollum's facial proportions. As the above notions on motion capture have shown, such differences are difficult to surmount and demand acute sensitivity to all the nuances of facial expression. Ultimately, however, it was impossible to capture every part of Andy Serkis's facial expression, because his on-set suit covered his face to some extent. Much to the disappointment of the animators, this meant that the live-action recordings could not be used for facial animation. Moreover, there were scenes that Serkis could not perform, such as certain climbing scenes or Gollum's plunge into the lava stream that spells his demise.

From the Gollum Case Study to Fundamental Notions on Digital Characters

As mentioned in the section on digital character construction (..), one of the greatest problems of computer-generated characters is consistency. In Gollum's case, the link between appearance and behavior is indeed very fragile. Both aspects have been accomplished with quite different techniques, and they draw on completely different sources. Surface and shape are the result of model building, albeit with the support of some additional recording and painting techniques. Behavior, by contrast, has been produced mainly by means of complex, computer-based recording techniques with additional keyframe animation. While loosely mediated connections exist between Gollum, the character, and Andy Serkis, the actor, Serkis is the starting point for behavior, which almost entirely obeys the laws of physics and touches on the fantastic only marginally.

The key link between behavior and appearance is therefore neither technical consistency nor any standard reference, but rather the character's narrative construction which is based on a strong back-story and an intelligently construed personality structure stemming from Tolkien's literary source. Gollum's background and his individual development under the influence of the magical and corrupting force of the ring are part of the story, and they are depicted in a flashback of his transformation from a character possessing normal human features into an ageless character somewhere situated between a child and an old man. While the schizophrenic traits repeatedly afflicting Gollum/Sméagol could endanger character consistency, I would argue that they instead enhance audience

participation with this strange creature. I will discuss its position within the group later, since it shifts the character on the continuum between flat and round characters gradually toward the latter through increasing complexity.[27]

33 Gollum

Character conception clears the second obstacle, the modeling of complexity, by the use of some highly ingenuous tricks (figure 33): first, the very sparse hair growth, consisting of 25 wisps, which drastically simplified hair modeling and animation; and secondly, the desperately oversized eyes and ears, which prevents alignment with reality from the outset. The mouth, with its bad teeth and dark tongue, conceals one of the notorious problem areas of computer animation, namely the oral cavity that often seems like a black hole. Finally, the dirty, weathered skin, covered in scars and wrinkles, roughens the all too even impression of computer graphics with carefully cultivated ugliness. Furthermore, this ugliness is functionally integrated into character conception by representing a multifaceted expressive potential of its own. As so often in cinematic representation, the physique displays inner psychological circumstances through outer, visible features (see Murray Smith 1995: 113).

To resolve the problem of interaction, Andy Serkis served as an on-set proxy. I have discussed the proxy approach in detail in the context of compositing (Flueckiger 2008: 220). Gollum is a very plausible example of how a proxy enhances staging, timing, and physical interaction. Without highly developed technical prerequisites, however, this approach would be impossible: it requires progress with the creation of traveling

27 The distinction between flat and round characters goes back to Edward M. Forster (see Taylor/Tröhler 1999: 142; Murray Smith 1995: 117).

mattes (Flueckiger 2008: 207 ff.) and with digital retouching (removal, painting). Retouching is itself very demanding and work-intensive, since the suit-wearing actor must first be removed from the film, and missing parts (background, objects, and characters) must also be painstakingly reconstructed, because Gollum's wiry constitution occupied decidedly less space in the image than Serkis's. Ideally, information missing from the image can be extracted from a *clean pass* without the actor; in all other cases, meticulous manual operation is called for, performed by a team of 45 compositors in conjunction with 25 rotoscope and paint artists in the case of The Lord of the Rings (cinefex 92: 90). Moreover, excellent tracking software (Flueckiger 2008: 243) is necessary to extract the camera data from the images if no motion control was used during the shoot, or to calculate the character's motion data from the images, and – in combination with the survey data of the set – to reconstruct the topology on which the digital character is meant to move.

Once the fundamental conceptual and technical problems have been resolved, the question arises about the deeper layers of audience participation, which can be best grasped with the notion of *empathy*. In contrast to identification, empathy implies not only an emotional involvement with the characters' feelings, but also a cognitive evaluation of their behavior. Various studies have shown that the emotional responses to a character are highly complex, since narrative information and its assessment are intertwined, based not only on textual references and a knowledge of the real world but also on a culturally binding morality (see Smith 1999: 220 ff.). In particular, this moral evaluation applies to the emotional responses to an antagonist like Gollum. Additionally, it is considerably easier to use computer graphics to create an antagonist than a likeable character, since the perceived distance to the digital character supports negative emotions, such as the T-1000 in James Cameron's Terminator 2 (USA 1992).

Gollum's conflicting intentions are just as essential as threatening to the protagonist's, Frodo's aim; namely, to break the destructive force of the ring. His position within the group thus evokes mixed feelings, involving anger, perhaps even hatred and disgust in combination with amusement or even care. These ambivalent reactions are anticipated by the specific character conception through the personality's schizophrenic traits, as manifest in two key scenes in The Two Towers (2002) and The Return of the King (2003), in which Gollum addresses his alter ego as a reflection in the water. In terms of narrative technique, these scenes and several others, in which he talks to himself in a childlike manner, provide the spectator with more knowledge than the protagonists have, since Gollum clearly announces his intention to kill the Hobbits in order to secure possession

of the ring forever. Such private moments of soliloquy or of reflection in front of a mirror, which also play a central role in Hulk, The Mask, or Spider-Man, are moments of truth, since cultural and social rules are cancelled; here, the true self discovers its unfiltered expression (see Plantinga 1999: 251).

From time to time, however, moments of amusement and *comic relief* about this quirky character enter reception. Gollum seems comical and cute – not only because he is often naïve, but also due to his physical appearance, which corresponds largely to the *baby schema* ("Kindchen-schema") presented by Konrad Lorenz in 1943.[28] This schema consists of various features, among others chubby cheeks, a small nose, large eyes, a high forehead, and a large head. Lorenz argued that these key stimuli instinctively trigger nurturing responses in adults, and thus inhibit possible aggressive reactions.

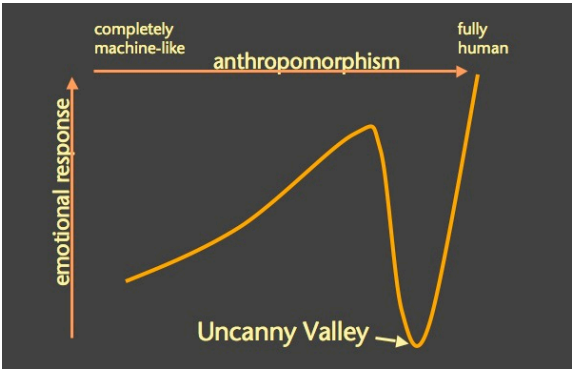
Interestingly, the history of the baby schema began in filmic representation before Lorenz grasped the concept in analytical terms. Thus, already Betty Boop (figure 34), created by Max Fleischer in the 1930s, corresponds to this schema; many other examples in film and comic strips followed – most recently in Japanese anime movies. Worth mentioning in this respect is especially Steven Spielberg's E.T. – The Extraterrestrial (USA 1982; see figure 35), who combines childlike features with those of an old man.

34, 35 Betty Boop as an example of the baby schema; E.T. – part child, part old man

28 See Konrad Lorenz (1943): Die angeborenen Formen möglicher Erfahrung. In: *Zeitschrift für Tierpsychologie*, Vol. 5, No. 2, 235–409.

There, too, a rudimentary, childlike use of language featuring typical grammatical errors – the use of the third person instead of the first-person I, generalizations, omissions – enhances the impression of cuteness. Overall, such different, often contradictory character traits create the image of a cunning, partly dangerous, yet at the same time witty character full of surprises. Moreover, this character undermines the sometimes oppressive pathetic impetus of the fantasy universe in a refreshing manner – even if the spectator is unaware of the technical virtuosity involved, that is, when he or she lacks paratextual knowledge.

Within a further cultural context, it makes sense to refer to a popular theory generally concerned with the acceptance of artificial characters; namely, Masahiro Mori's theory of the *Uncanny Valley* (the Japanese term is *Bukimi no tani*, Mori 1970). Developed in the context of robotics, Mori's theory assumes the following rules: the more anthropomorphic an artificial character looks, for example a robot, the more familiar it seems and the more emotions it evokes. If, however, this character appears almost entirely human, an opposite, distancing effect occurs, which Mori calls the *Uncanny Valley*. Not until the character seems completely human does the positive effect prevail to attain maximal value (figure 36).

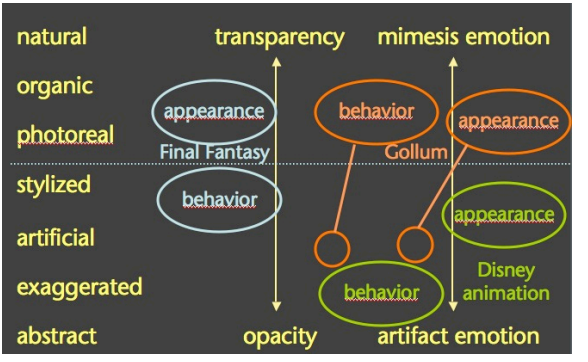


36 The *Uncanny Valley*

Mori takes the example of a hand prosthesis, which looks quite natural, but nevertheless still feels unnatural. Visual effects practitioners are familiar with this theory (cinefex 100: 77). Many consider the characters in Final Fantasy a prime example of the Uncanny Valley's effect on the audience's emotional reaction. Photorealistic on the surface, these characters lack various human traits. They seem not to breath and they have a very limited expressive repertoire. In short, they seem somehow

dead. According to Mori, it is this association with death, or more precisely with the living dead (that is, zombies), which evokes the distancing effect. Another conceivable explanation would be the sense of strangeness that occurs when a human being's behavior deviates from social and cultural norms, such as when someone maintains no eye contact when addressed, but instead rolls their eyes, without any evident impairment accounting for his violation of these norms.[29]

Not all digital characters fit into this model, however; one case in point is Gollum, who seems human for the most part, but diverges from it in some respects. We must therefore seek alternative explanatory models able to comprise such cases as well. I propose the *model of distance*, which is more an approach than a theory. Following prototype theory, I use the notion of *distance* as a measure of deviation from a defined standard value (see Kluwe 1990: 155).



37 The model of distance

To discuss this approach, I refer to the above matrix (figure 37). It depicts the various parameters, arranged on the left side in a continuum spanning the natural to the abstract. At one end there are hypothetical, transparent forms of representation, which afford an undistorted view of the depicted object world, comparable to looking out of a window,

29 Concerning the theory of the Uncanny Valley it has to be noted that we would need empirical evidence whether a given character has passed it or not. In a critical discussion of the digital characters in AVATAR, only half of the audience believed that the Na'vi characters were beyond the Uncanny Valley.

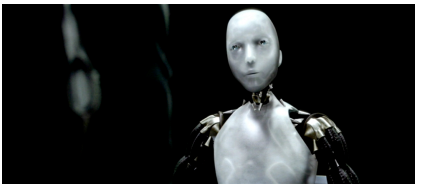
and thereby evoke emotions through mimesis.[30] At the other end there are opaque forms of representation that guide attention toward their own materiality and/or virtuosity, and thereby evoke artifact emotions (Tan 1996). My hypothesis is that the different aspects of a character should be situated at a similar distance from a transparent mode of representation. Between photorealistic and stylized depictions there runs a fine yet essential line, which separates fundamentally different forms of representation. Every feature of a digital or artificial character can be projected onto this matrix, whereby "appearance" and "behavior" need to be treated as isolated entities for analytical reasons already discussed in the context of character consistency (..).

According to this hypothesis, the characters in Final Fantasy fail, because the above-mentioned essential line runs between stylized behavior and photorealistic appearance. Animators of the classical school incessantly emphasize how important it is to adhere to Disney's tenth rule of animation (Flueckiger 2008: 125 et seq.); namely, to exaggerate movements to convey the (stylized) character's emotions. Many fully computer-animated movies – from Shrek (USA 2001, Adamson/Jenson/Marshall) over Finding Nemo (USA 2003, Stanton/Unkrich) to The Incredibles (USA 2004, Brad Bird) – refer to the rules of cartoons by using artificial characters and strongly accentuated plot elements, that is, in accordance with the model of distance.

Gollum is yet another case. His behavior and appearance seem predominantly photorealistic and organic, involving some deviations that can be classified as fantastic or at least as unusual, among others his large ears and eyes, or his moving around on all four extremities. While these deviations are satellite-like extensions, they do not imbalance representation, since they occur equally in both categories (behavior and appearance).

We can now return to the question whether a connection can be established between this hypothesis and the techniques used for character construction. Sonny the robot in I, Robot can be compared to Gollum, because he was created using similar techniques: Alan Tudyk, Sonny's proxy, first established on-set interaction with the other characters and then repeated his performance on the motion capture stage; secondly, Sonny's face was keyframe-animated in close alignment with Tudyk's facial expression, while the character's shape was modeled. Sonny also

30 In my conception, mimesis emotions differ slightly, but essentially from Ed Tan's notion of "F-emotions" (Tan 1996: 65 f.). F-emotions describe fictional emotions, that is, emotions produced by fiction, while mimesis emotions result from the perception of a familiar, natural seeming world.



38, 39 Subjective perspective of the robot in I, Robot; no baby schema: Sonny

occupies a similar position within the network of characters: he appears to be an unpredictable antagonist and often seems naïve because he lacks some essential knowledge to understand the world. One typical scene in this respect occurs when he sees Detective Spooner winking at a colleague (figure 38), and wants to know what this mimic expression means.[31]

However, this naïvety is not reflected in a childlike physique (figure 39), and Sonny's use of language is not childlike either. In any case, his appearance is far removed from any organic form, which impedes empathic participation, because Sonny strikes us as cold and plastified. These material properties have an evidently distancing effect: one would rather not touch him.

In a decisive scene, in which Sonny is supposed to be shut down, the narrative partially shifts perception toward his subjective perspective. Music and fragmented memories represented as flashbacks, which in fact are related to Detective Spooner, and a slow, solemn circular tracking shot are meant to support the emotional impact of the scene. Only an empirical investigation would reveal whether it is on account of this sentimental scene that we connect with this rather repulsive-looking character, but at some point we nevertheless do. Given that his facial expression appears very stylized and possesses a merely limited repertoire this is even more astonishing. Despite motion capture, motion patterns frequently depart from a plausible physical basis, and shift into the realm of super-heroic invincibility. Narrative construction is thus also the most important emotional basis in I, Robot; here, too, such a construction has a strong background story, since Sonny ultimately turns out to be a robotic incarnation of his creator's thought world. While this character construction is inserted into a rather stereotypical story scheme – David versus Goliath, individual versus powerful corporation –, he nevertheless manages to develop into a round, fleshed out character due to his complexity.

31 Similar aspects are typical of characterizing cyborgs. Among others, they are a recurrent motif as a running gag for Data in the Star Trek universe.

Attempting to project Sonny onto the model of distance entails a pattern almost complementary to Gollum's. Sonny's appearance has been stylized using a photorealistic look, just as his stylized behavior integrates organic to natural elements like the satellites mentioned in the case of Gollum. Instructed by a choreographer, Tudyk and the other proxies representing the robots explicitly adopted a specific motion pattern, which was subsequently transferred onto the robots using motion capture. Photoreal and stylized elements of representation are thus interwoven to form a network, which overcomes their dividing line, equally with regard to appearance and behavior.

Alongside narrative construction, the proxy model is a reliable technique for establishing a solid foundation for character consistency. Moreover, a proxy adds another aspect to character representation: his existence in real life. As discussed in the introduction to this chapter, such existence and its related associations import extended meaning into character construction, namely, the very history that digital characters often lack. The studio and Peter Jackson were variously and justifiably criticized (see the discussion in cinefex 100) for placing too much emphasis on acting performance, while the tremendous achievement of the CG team, especially Raitt's team of animators, was downplayed. From the perspective of reception psychology, however, such foregrounding was a clever move, because in attributing this achievement to one person, the digital character attains something akin to a physical presence, which is far more concrete than the abstract and incomprehensible operations of a host of animators. Such a personality cult even enters scholarly discourse which tends to credit major innovations to a single individual, who has already acquired a symbolic status, like George Lucas, Steven Spielberg,[32] or possibly Dennis Muren at ILM. This fundamental need is satisfied by the focus on Andy Serkis, who not only features prominently in the DVD bonus material, but also published his own diary for the purpose of marketing (Serkis 2003).

To conclude these reflections, I would like to return to the example of The Polar Express. I agree with the *New York Times*, which considered the movie a failure and described the characters as "creepily unlifelike."[33] Like Final Fantasy, The Polar Express is a shining example of Mori's Uncanny Valley, since the characters come across as almost completely

32 A recent example of this trend is James Cameron with Avatar.

33 Probably even more evidently the lack of awards proves that industry professionals considered the movie a failure. Only the character of Steamer received a nomination by the Visual Effects Society VES for an award in the category Outstanding Performance by an Animated Character in an Animated Motion Picture.

human. Considering the relation between stylization and photorealism allows us to better understand this failure. Part of the problem, I would argue, arises from the curious dissonance between a too human behavior and a stylized appearance. However, this dissonance mainly concerns the children, the father, and the character of the conductor, of which no less than three are played by Tom Hanks. It concerns less Hobo and Father Christmas, because their behavior is evidently situated within fantasy, both through the narration as part of the parallel fantasy universe and through their motion, which is far more cartoony. Behavior and appearance thus seem more consistent. Such dissonance applies least to the character of Steamer, however. While played by an actor, he was ultimately entirely keyframe-animated (SIGGRAPH 2005, Course No. 28: 36). Therefore the gap between appearance and movement patterns is closed even further, since both are decidedly artificial. This interesting finding fits perfectly into the theory of the Uncanny Valley and also into the model of distance.

At the same time, the human looking characters lack essential constituents of touching facial expression, for evidently technical reasons. In terms of the facial animation pipeline described above, too many individual details are lost in this arrangement – due to filtering and transfer onto very different facial proportions. On the other hand, motion capture suggests that each facial emotion has a basis in reality, perhaps explaining why in some cases keyframe animation was not used to make urgently needed corrections. By far the most serious problem, however, concerns the eyes that struck me on seeing the movie for the first time, long before I knew about the technical difficulties involved. Gazes seem to swim, they are too undecided, and one never has the impression that the characters are actually looking at one another, which is quite unsettling. Especially the boy's eyes lack astonishment, which would be essential for conveying the magical quality of the fantastic world. In contrast to I, Robot and The Lord of the Rings, the narration in The Polar Express cannot perform the fundamental task of endowing the characters with psychological depth. The narrative center is missing. Both the individual characters and their constellation fall apart. The Polar Express is based on a very well known children's book, and the film was a commercial success. Arguably, its success was probably due to the famous literary source. Furthermore, a clever marketing foregrounded Tom Hanks to satisfy the audience's need for personalization and had The Polar Express follow the established tradition of the family Christmas movie.

The above discussion makes evident that the construction of digital characters must balance numerous separate factors. Technology alone

does not suffice – but if the technology fails, sophisticated narration can offset its shortcomings only to a certain extent.

The Superhero Problem

Based on the above reflections, I would like to close this essay by asking whether we can identify general principles to determine if, when, and why audience participation succeeds even though characters possess superhuman abilities, exhibit and deploy spectacular bodies, become subject to dramatic transformation, or appear in enormous masses – in short, when movies indulge in excess without restraint.

We should, however, not expect to find either generally valid or hard-and-fast rules. We should not expect to do so for methodological reasons. First, audience participation is historically and culturally situated: what succeeds at a particular time and under certain circumstances need not happen in another context. Secondly, individual differences apply just as with every emotional reaction. Using personality profiles could allow for examining the relationship between a viewer's disposition and his or her emotional response to individual movies; even then, however, the aesthetic and narrative aspects involved in this interaction would remain as unclear as the question which emotional reactions were to be measured how. If there were no principle obstacles, Hollywood would have long devised a corresponding set of rules, in order to produce only successful films and to optimize box office returns ad infinitum, for audience participation is a highly valuable asset. Eventually, most people go to the cinema to experience emotions.

Digitization or the digital modification of the represented body in cinema has intensified the question how strongly such body displays can detach themselves from their physical-physiological basis, without severing the link with the spectator. Many practitioners are aware of this danger. Alex Laurant, who worked as a visual arts director at Industrial Light & Magic for many years, mentioned in a 2005 interview that the guiding rule at ILM was to subject all character action and each camera movement strictly to the laws of physics. But the rule has meanwhile been either revoked or partially subverted, because one typical example of the superhero problem is Hulk, whose visual effects were created at ILM under the direction of Dennis Muren.

A survey of characters who at least temporarily transcend the human sphere of action and renounce their consistent identity by switching between various configurations, behavioral repertoires, and personality traits suggests that various conditions seem to frame this model. Such

a framework includes narrative or stylistic aspects. Most superheroes are caught up in a moral conflict that evidently weakens a part of their personality, as Oropeza (2005: 1 ff.) has shown. They have no parents and run into trouble with the law. This conflict is often rooted in the traumatic experience that entailed their mutation and the subsequent development of superhuman abilities. Batman, Superman, Spider-Man, X-Men, Daredevil, and Blade are typical examples of this pattern. They address adolescent spectators in particular and provide them with an allegorical solution to their puberty problems, which are characterized by the typical oscillation between fears of loss and failure on the one hand, and fantasies of omnipotence on the other. These characters confront the law with their own, higher notion of justice, since they experience it as corrupted by dark powers. They are thus profoundly moral in their sense of pursuing a mission. Often conceived as saviors, they are oriented toward religious motifs, and can thus be understood in a Christian sense as Jesus-like figures, such as Superman (Kozloff 1981) or Neo in The Matrix.

Various narrative strategies exist to curtail the infinite possibilities of the superheroes, to endanger them, and to thus maintain suspense. Because we could cease to engage with them, if their behavioral repertoire transgresses all human proportion when their actions exceed the familiar. Suspense collapses if they are capable of achieving everything. The threatening powers are mostly personified by an antagonist, who should be understood in a wider sense as the representative of a dark power to be opposed – like Magneto in X-Men, who strives to annihilate the whole of humanity and leverages the political establishment to this end; or like the agents, especially Agent Smith, as personifications of the matrix, who aspire to exploiting humanity; or indeed Norman Osborn, the mutated father of Spiderman's friend Harry, as a representative of corrupt capitalism. This list could be extended. In that the antagonists command a more sophisticated weapons and skills arsenal, the balance of terror is preserved, and the protagonist remains threatened despite his fantastic powers.

In the Matrix sequels, for instance, the lack of balance presumably accounts for the breakdown of participation, and threatens to turn the conflict into a meaningless spectacle. Whereas Part 1 features Neo as a naïve simpleton, who is confronted with events that he can neither oversee nor control, this development is consolidated by the end of the first movie when he is able to purposefully apply his mental abilities to pulverize the agents into a pixel cloud. Part 1, however, already presented the danger of actions occurring in the simulated world of the matrix to

appear disconnected from reality, and therefore lack any kind of relevance. "Violence and death merely cast us back onto another level," Stiglegger observes (2001: 25 f.), and indeed some of Morpheus's rhetorical finesse is required to attenuate the purely playful character of the alternative world and to assign real consequences to the actions occurring in the simulation.[34]

The dangerous arsenal of the villains and of other ambivalent characters includes the ability to morph at will into another phenotype. Surely the most famous primordial type of a morph is the evil terminator T-1000. The Borg Queen in Star Trek: First Contact (USA 1996, Jonathan Frakes) followed him, the character of Mystique in X-Men, and Agent Smith in The Matrix. A morph is an enemy whose changeable shape allows him to perfectly adapt through mimicry to any given situation, and thereby calls into question the traditional strategies of recognizing and identifying a person. Such extremely fluid character conception devilishly subverts the protagonist's perceptual and discerning abilities, and thus fundamentally unsettles him and the audience alike, just as the false Maria in Fritz Lang's pre-digital Metropolis, who looked deceptively similar to the real one. Luc Besson's The Fifth Element (France/USA 1997) plays with this motif in an ironic manner, and partly morphs the evil Mondoshawans who try to adopt the innocent appearance of pleasant-looking African Americans (figure 40), involuntarily back into their original guise (figure 41).

Mostly, such perfect machines like the replicants in Ridley Scott's Blade Runner (USA 1982), which can hardly be distinguished from humans, are not digital characters. Rather, as Samocki rightly observes (2002: 135), they are embodied by actors made of flesh and blood. Cases in point include David, the robot child, in Steven Spielberg's A.I. – Artificial Intelligence (USA 2001), Data in the Star Trek universe, and the old terminator, who only partly brings into play his superhuman abilities – unlike Daryl, the virtual character in Virtuosity, who is conceived as an almost invincible antagonist.

In addition to being threatened by an adversary, these characters all have an Achilles heel that makes them susceptible to injury. Often their weaknesses are closely intertwined with a moral dilemma, like in Spider-Man and Daredevil, in which the limits of a morally justifiable handling of their powers is a perennial topic. This dilemma is further heightened by the protagonists' need to lead a double life, and to conceal their second identity as a superhero from their everyday environment. In their

34 Neo: "If you are killed in the matrix, you die here?" Morpheus: "The body cannot live without the mind."

40, 41 A seemingly innocent person morphs involuntarily back into an evil Mondoshawan

modest existence as average persons both heroes have a love interest, as well as other relationships that would be jeopardized if their second identity were revealed. Spider-Man and Daredevil are – or appear to be – guilty, because they either misuse or misdose their powers at critical moments. In Daredevil, moreover, a dramaturgical trick is used to underline the protagonist's vulnerability; namely, the anticipation of a near-death experience, from whose perspective his life is once more unfurled. This flash-forward to the future grants the spectator more knowledge than the characters, and thereby creates suspense.

In Sleepy Hollow (USA 1999, Tim Burton), The Mummy, Death Becomes Her (USA 1992, Robert Zemeckis), and Interview with the Vampire (USA 1994, Neil Jordan), the antagonists are undead or immortal, whereas in Blade and Alex Proyas's The Crow (USA 1994) it is the protagonists that exist in a shadow world between life and death. This life is laden with particular burdens – the inability to die is a curse that is mocked only in Death Becomes Her. Precisely the Gothic versions of the superheroes, such as Blade and The Crow, are anything but ironically distanced; they remain utterly serious and therefore depend on the spectator's empathy with the characters.

Thus, the above superhero movies are character-centered and bound to the classical opposition between good and evil. They do not belong to

the post-human cinema that Beebe (2000: 163) identifies in Terminator 2, where – according to her – the absence of a human center shifts affective participation toward the mode referred to by Tan (1996: 65 f.) as artifact emotion: the affective value of the sensory dimension and the spectacle. Some few of the works among those investigated fit into this schema, albeit with certain restrictions: The Mummy, Hollow Man, XXX, and Tomb Raider (USA 2001, Simon West); these are all largely conceived as action films involving characters lacking any psychological depth.

All superhero movies, however, are marked by exceedingly accented, more or less successful stylization. They all involve depictions of violence where aesthetics and editing pace are foregrounded to an unusual degree.

Such aesthetic coding of these depictions needs to be situated between two poles that both have a distancing effect: the first is a self-reflecting, ironically excessive, cartoon-like violence; the second is an overly accented, bizarre presentation mode. Both forms of violence originate in burlesque and slapstick, that is, two physical genres in which physiological shock effects and the deconstruction of the subject are most happily coupled. The aestheticization of a once raw violence entails yet a further distancing effect, and thus maximizes the space available for the playful experience of violence and aggression from the safe distance of the cinema seat (Smith 1999: 230). Even Benjamin described the stylized representation of violence performed by Mickey Mouse as "mental training," involving a cathartic effect that "renders unnecessary the acting out of violence" (Bratze-Hansen 1995: 262). The aestheticization of violence was, however, always flawed; there was something fascistoid about it that early became evident in Futurism's glorification of war and aggression. Now, however, this aestheticization has itself undergone change: it is no longer a question of the beautiful or the pure, but instead a matter of establishing direct physical experience,[35] a stylization of the raw and uncultivated – a tendency represented, among others, by David Fincher's Se7en (USA 1995) and Fight Club, Tarantino's movies, or by Frank Miller's and Robert Rodriguez's Sin City (USA 2005). As Murray Smith rightly observes (1999: 232 f.), these films require the indignation of an educated, middle-class, adult audience to be perceived as cool and hip, and thus to evoke higher-order pleasure among a certain audience, or what Bartsch has called

35 In his book *Moving Viewers* (2009) Carl Plantinga offers an interesting discussion of phenomena of "direct affect", where films address first and foremost the viewer's sensory reactions.

meta-emotions (2005).[36] The impetus to shock middle-class attitudes *(épater le bourgeois)* fuses various anti-bourgeois tendencies in a celebration of pure stimulus, as I have discussed elsewhere (Flueckiger 2001: 122, 264 et seq.).

Ultimately, the stimulus dimensions themselves, that is, the extreme states represented by bodies, bring forth a third form of affect; namely, the "phenomenon of a more or less virtual, more or less automatic physical accompaniment," which Brinckmann (1999: 111 f.) has discussed under the notion of *motor mimicry*. Such immediate affective participation is bound to find expression whenever superheroes exert or experience extreme violence, just as whenever they superhumanly control their bodies when they jump off roofs, master martial arts, swing on ropes through urban canyons – provided that suspense is preserved, which takes us back to narrative strategies.

If these extremes were not underpinned by a mesh of parallel strands that support both cognitive and emotional participation, then presumably such immediate reaction also collapses. At least that is how I experience movies from which I have bailed out – bored stiff – both mentally and emotionally. Spectacle instead of narration is therefore probably an exception, while spectacle combined with narration is the rule, at least in the Hollywood blockbuster.

36 "A Three Level Approach to Meta-emotion." Paper given at the conference on Audiovisual Emotions, Hamburg, 3 December 2005.

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